FORM PTO-1390 (REV. 11-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
32860-000306/US	10/089893

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/03504	October 5, 2000	October 5, 1999

TITLE OF INVENTION
VACUUM CONTACTOR

APPLICANT(S) FOR DO/EO/US
Johann DREXLER; Markus KROPP; Bardo KOPPMANN; Markus MEIER and Norbert MITLMEIER

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39 (1).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau). WO 01/26127A1
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is transmitted herewith.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4)
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98-1449 and International Search Report (PCT/ISA/210) in German with Four (4) references and a German Translation Aid.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☒ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:
    1) Two (2) sheets of Formal Drawings
    2.) Article 34 Amended Specification and Claims

10/089893 JC13 Rec'd PCT/PTO 05 APR 2002

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
NEW 10/089893	PCT/DE00/03504	32860-000306/US

21. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. **$1,040.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO. **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4). **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ **890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ **130.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	20 - 20 =	0	X **$18.00**	$ **0**	
Independent Claims	3 - 3 =	0	X **$84.00**	$ **0**	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)		None	+ **$280.00**	$ **0**	
TOTAL OF ABOVE CALCULATIONS =				$ **1,020.00**	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$ **0**	
SUBTOTAL =				$ **1,020.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐20 ☐30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ **1,020.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ **0**	
TOTAL FEES ENCLOSED =				$ **1,020.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of $ **1,020.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account. No. 08-0750 in the amount of $ to cover the above fees. A triplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 08-0750.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:
Harness, Dickey & Pierce, P.L.C – Customer No. 30596
Post Office Box 8910
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Date: April 5, 2002

By _____
Donald J. Daley, #34,313

/bab

PATENT
32860-000306/US

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicants: Johann DREXLER; Markus KROPP; Bardo KOPPMAN; Markus MEIER; Norbert MITLMEIER

Int'l App. No.: PCT/DE00/03504

Application No.: **NEW**

Filed: April 5, 2002

For: VACUUM CONTACTOR

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

April 5, 2002

Sir:

The following preliminary amendments and remarks are respectfully submitted in connection with the above-identified application.

IN THE ABSTRACT

Please replace the Abstract with the attached revised Abstract.

IN THE CLAIMS

Please amend the claims as follows:

1. (Amended) A vacuum contactor, comprising:

a contactor housing;

a drive coil;

an armature;

an operating element; and

at least one vacuum contact, wherein the drive coil is adapted to deflect the armature from an armature rest position to an armature operating position when a pull-in

current is applied, wherein the deflection of the armature is adapted to cause the operating element to be deflected from an element rest position to an element operating position, wherein the deflection of the operating element is adapted to result in closing of the at least one vacuum contact, wherein when the armature is deflected from the armature rest position to the armature operating position, the armature is adapted to first pass through an initial movement distance and is then adapted to pass through a driving movement distance, with the operating element being deflected by the armature only while the armature is passing through the driving movement distance, and wherein the operating element is adapted to always either remain in the element rest position or be deflected completely to the element operating position when a current that is less than the pull-in current is applied to the drive coil.

Please add the following new claims:

-- 2. The vacuum contact as claimed in claim 1, wherein the ratio of the initial movement distance to the driving movement distance is between 1:3 and 3:1.

3. The vacuum contactor as claimed in claim 1, wherein the ratio of the initial movement distance to the driving movement distance is between 2:3 and 3:2.

4. The vacuum contactor as claimed in claim 1, wherein the armature is deflected by the drive coil against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance, and wherein the initial movement force is less than the driving force.

5. The vacuum contactor as claimed in claim 4, wherein the ratio of the initial movement force to the driving force is between 1:10 and 1:2.

6. The vacuum contact as claimed in claim 4, wherein the ratio of the initial movement force to the driving force is between 1:5 and 1:4.

7. The vacuum contactor as claimed in claim 4, wherein the initial movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, wherein the initial movement spring device is supported firstly on the armature and secondly on the operating element, and wherein the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

8. The vacuum contactor as claimed in claim 1, wherein the operating element includes a stop, against which the armature is moved when it is deflected from the armature rest position.

9. The vacuum contactor as claimed in claim 2, wherein the armature is deflected by the drive coil against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance, and wherein the initial movement force is less than the driving force.

10. The vacuum contactor as claimed in claim 9, wherein the ratio of the initial movement force to the driving force is between 1:10 and 1:2.

11. The vacuum contact as claimed in claim 9, wherein the ratio of the initial movement force to the driving force is between 1:5 and 1:4.

12. The vacuum contactor as claimed in claim 3, wherein the armature is deflected by the drive coil against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance, and wherein the initial movement force is less than the driving force.

13. The vacuum contactor as claimed in claim 12, wherein the ratio of the initial movement force to the driving force is between 1:10 and 1:2.

14. The vacuum contact as claimed in claim 12, wherein the ratio of the initial movement force to the driving force is between 1:5 and 1:4.

15. The vacuum contactor as claimed in claim 5, wherein the initial movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, wherein the initial movement spring device is supported firstly on the armature and secondly on the operating element, and wherein the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

16. The vacuum contactor as claimed in claim 6, wherein the initial movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, wherein the initial movement spring device is supported firstly on the armature and secondly on the operating element, and wherein the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

17. The vacuum contactor as claimed in claim 2, wherein the operating element includes a stop, against which the armature is moved when it is deflected from the armature rest position.

18. The vacuum contactor as claimed in claim 4, wherein the operating element includes a stop, against which the armature is moved when it is deflected from the armature rest position.

19. A method of operating a vacuum contactor including a drive coil, an armature, an operating element, and at least one vacuum contact, comprising:

applying a pull-in current to the drive coil to deflect the armature from an armature rest position to an armature operating position;

causing, from the deflection of the armature, the operating element to be deflected from an element rest position to an element operating position;

causing, from the deflection of the operating element, closing of the at least one vacuum contact; and

causing, when the armature is deflected from the armature rest position to the armature operating position, the armature to first pass through an initial movement distance and then pass through a driving movement distance, with the operating element being deflected by the armature only while the armature is passing through the driving movement distance, and wherein the operating element is adapted to always either remain in the element rest position or be deflected completely to the element operating position when a current that is less than the pull-in current is applied to the drive coil.

20. An apparatus, comprising:

a vacuum contactor including a drive coil, an armature, an operating element, and at least one vacuum contact; and

means for applying a pull-in current to the drive coil to deflect the armature from an armature rest position to an armature operating position, wherein, from the deflection of the armature, the operating element is adapted to be deflected from an element rest position to an element operating position, wherein, from the deflection of the operating element, the at least one vacuum contact is adapted to be closed, wherein, when the armature is deflected from the armature rest position to the armature operating position, the armature is adapted to first pass through an initial movement distance and then pass through a driving movement distance, with the operating element being deflected by the armature only while the armature is passing through the driving movement distance, and wherein the operating element is

adapted to always either remain in the element rest position or be deflected completely to the element operating position when a current that is less than the pull-in current is applied to the drive coil. --

REMARKS

Claims 1-20 are now present in this application, with new claims 2-20 being added by the present Preliminary Amendment. It should be noted that the amendments to original claim 1 of the present application are non-narrowing amendments, made solely to place the claim in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations. For example, amendments have been made to broaden the claim; remove reference numerals in the claim; and to place the claim in a more recognizable U.S. form, including the use of the transitional phrase "comprising" as well as the phrase "wherein". Other such non-narrowing amendments include placing the apparatus-type claim (setting elements forth in separate paragraphs) in a more recognizable U.S. form. Again, all amendments are non-narrowing and have been made solely to place the claim in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations.

SUBSTITUTE SPECIFICATION

In accordance with 37 C.F.R. §1.125, a substitute specification has been included in lieu of substitute paragraphs in connection with the present Preliminary Amendment. The substitute specification is submitted in clean form, attached hereto, and is accompanied by a marked-up version showing the changes made to the original specification. The changes have been made in an effort to place the specification in better form for U.S. practice. No new matter has been added by these changes to the specification. Further, the substitute

specification includes paragraph numbers to facilitate amendment practice as requested by the U.S. Patent and Trademark Office.

CONCLUSION

Accordingly, in view of the above amendments and remarks, an early indication of the allowability of each of claims 1-20 in connection with the present application is earnestly solicited.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Donald J. Daley at the telephone number of the undersigned below.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

HARNESS, DICKEY & PIERCE, P.L.C

By: _____
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ABSTRACT OF THE DISCLOSURE

In a vacuum contactor, the armature is initially deflected from an armature rest position through an initial movement distance, and then through a driving movement distance to an armature operating position when a pull-in current is applied to a drive coil. An operating element is deflected from an element rest position to an element operating position by the armature only while the latter is passing through the driving movement distance. This makes it possible to achieve a good tripping characteristic of the vacuum contractor.

Patent claim

1. A vacuum contactor having a contactor housing (1), a drive coil (2), an armature (3), an operating element (4) and at least one vacuum contact,

- with the drive coil (2) deflecting the armature (3) from an armature rest position (AR) to an armature operating position (AB) when a pull-in current (IA) is applied,
- with the deflection of the armature (3) causing the operating element (4) to be deflected from an element rest position (ER) to an element operating position (EB), and
- with the deflection of the operating element (4) resulting in closing of the at least one vacuum contact,
- with, when the armature (3) is deflected from the armature rest position (AR) to the armature operating position (AB), the armature (3) first of all passing through an initial movement distance (sV), and then passing through a driving movement distance (sM),
- with the operating element (4) being deflected by the armature (3) only while the latter is passing through the driving movement distance (sM),
- with the operating element (4) always either remaining in the element rest position (ER) or being deflected completely to the element operating position (EB) when a current that is less than the pull-in current (IA) is applied to the drive coil (2).

SUBSTITUTE SPECIFICATION

VACUUM CONTACTOR

[0001] This application is the national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/DE00/03504 which has an International filing date of October 5, 2000, which designated the United States of America, the entire contents of which are hereby incorporated by reference.

Field of the Invention

[0002] The present invention generally relates to a vacuum contactor. Preferably, it relates to one including a contactor housing, a drive coil, an armature, an operating element and at least one vacuum contact. Even more preferably, the drive coil deflects the armature from an armature rest position to an armature operating position when a pull-in current is applied. The deflection of the armature then causes the operating element to be deflected from an element rest position to an element operating position. Finally, the deflection of the operating element results in closing of the at least one vacuum contact.

Background of the Invention

[0003] CH-A-169 467 discloses a vacuum contactor having a contactor housing, a drive coil, an armature, an operating element and at least one vacuum contact:

- with the drive coil deflecting the armature from an armature rest position to an armature operating position when a pull-in current is applied,
- with the deflection of the armature causing the operating element to be deflected from an element rest position to an element operating position,
- with the deflection of the operating element resulting in opening of the at least one vacuum contact,
- with, when the armature is deflected from the armature rest position to the armature operating position, the armature first of all passing through an initial movement distance, and then passing through a driving movement distance, and

- with the operating element being deflected by the armature only while the latter is passing through the driving movement distance.

[0004] GB 1 432 372 A discloses an air contactor having a contactor housing, a drive coil, an armature, an operating element and at least one contact:

- with the drive coil deflecting the armature from an armature rest position to an armature operating position when a pull-in current is applied,
- with the deflection of the armature causing the operating element to be deflected from an element rest position to an element operating position,
- with the deflection of the operating element resulting in closing of the at least one contact,
- with, when the armature is deflected from the armature rest position to the armature operating position, the armature first of all passing through an initial movement distance, followed by a driving movement distance, and
- with the operating element being deflected by the armature only while the latter is passing through the driving movement distance.

[0005] In contactors, the armature and the operating element, together with the armature, are generally deflected against a spring force when the pull-in current is applied to the drive coil. The spring force thus acts in the direction of the armature rest position and of the element rest position. This spring force must be overcome by the pull-in torque which the drive coil exerts on the armature as a result of the pull-in current. The pull-in torque is dependent on the pull-in current, which is in turn dependent on the supply voltage that is supplied to the drive coil.

[0006] Both the pull-in torque and the spring force in the opposite direction vary along the distance through which the armature and the operating element are deflected. If the contactor is not well designed, it is thus possible for a situation to occur in which, if the supply voltage is too low, although the armature and the operating element are deflected from their rest positions, the armature and the operating element are not deflected to their operating positions, however. In a case such as this, the armature and operating element either remain stuck in an intermediate position, or a contact which is operated by the operating element is only operated without a pressure. Depending on the duration of this state, this can lead to high wear, and generally also to damage, while in the extreme case, it can even lead to destruction of the contactor.

[0007] In the case of air contactors, that is to say in contactors whose contacts are surrounded by air, it is possible to design these contactors such that the armature and operating element are either not deflected at all from their rest positions or else are moved completely to their operating positions. Such a contactor characteristic is referred to as a tripping characteristic.

[0008] Vacuum contactors require a greater spring force in the opposite direction than air

contactors. This is because the vacuum pressure forces which would initiate autonomous operation of the contacts must be overcome. Until now, for vacuum contactors, it has been regarded as being impossible to achieve a tripping characteristic just on the basis of the mechanical/electrical design of the contactor. Vacuum contactors according to the prior art therefore either do not have a tripping characteristic or else drive electronics are connected upstream of the drive coil and apply the supply voltage to the drive coil only when the supply voltage is high enough to ensure that the armature and operating element will reliably be moved to the operating positions.

SUMMARY OF THE INVENTION

[0009] In an embodiment of the present invention, if the vacuum contactor is designed in a suitable manner, it is possible to achieve a tripping characteristic even without any upstream drive electronics. A vacuum contactor has been created, in one embodiment of the present application, in which the operating element always either remains in the element rest position or is deflected completely to the element operating position when a current that is less than the pull-in current is applied to the drive coil.

[0010] This can occur because, for example, the force which needs to be overcome along the initial movement distance can be chosen independently of the contact arrangement. In particular, it can be chosen independently of the fact that vacuum contacts are being operated. This allows a tripping characteristic to be achieved, if the vacuum contactor is designed in a suitable manner.

[0011] In vacuum contactors, arcs can be quenched even with small contact openings. Vacuum contactors therefore generally have shorter switching movements than air contactors. The dimensions that are known for air contactors can thus be used, provided the sum of the initial movement distance and the driving movement distance correspond to the contact movement distance of an air contactor. In practice, this corresponds to the ratio of the initial movement distance to the driving movement distance being between 1:3 and 3:1. In general, the ratio of the initial movement distance to the driving movement distance is between 2:3 and 3:2.

[0012] As already mentioned, the armature can be deflected against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance. A tripping characteristic can be achieved in a particularly highly reliable manner if the initial movement force is less than the driving force. In practice, this normally means that the ratio of the initial movement force to the driving force is between 1:10 and 1:2, in particular between 1:5 and 1:4.

[0013] The physical design of the vacuum contactor can be particularly simple if the initial

movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, the initial movement spring device is supported firstly on the armature and secondly on the operating element, and the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

[0014] If the operating element has a stop, against which the armature is moved when it is deflected from the armature rest position, the initial movement distance can be defined exactly in a particularly simple manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Further advantages and details can be found in the following description of an exemplary embodiment. In this case, illustrated in outline form,

Figure 1 shows a vacuum contactor in the unoperated state,

Figure 2 shows the vacuum contactor from Figure 1 in the operated state, and

Figure 3 shows a force and movement profile plotted against the armature movement distance.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Figure 1 shows a vacuum contactor with a contactor housing 1. Only part of the contactor housing 1 is shown in Figure 1. A drive coil 2 is mounted rigidly in the contactor housing 1. An armature 3, an operating element 4 and a contact link 5 are also mounted, such that they can move, in the contactor housing 1.

[0017] The contactor has an initial movement spring device 6, a driving spring device 7 and a contact-making spring device 8. According to the exemplary embodiment, the spring devices 6-8 are in the form of compression spring devices. However, they could also be of other different configurations, for example they could be in the form of rotary spring devices, etc.

[0018] The initial movement spring device 6 is supported firstly on the armature 3 and secondly on the operating element 4. The driving spring device 7 is supported firstly on the operating element 4 and secondly on the contactor housing 1. The contact-making spring device 8 is supported firstly on the operating element 4 and secondly on the contact link 5.

[0019] When no current is applied to the drive coil 2, the initial movement spring device 6 presses the armature 3 against an upper operating element stop 9. The driving spring device 7 presses the operating element 4 against a housing stop 10. The contact-making spring device 8 presses the contact link 5 against a contact link stop 11. The armature 3 is thus in an armature rest position AR, the operating element 4 is in an element rest position ER, and the contact link 5 is in a link rest position. This position is shown in Figure 1.

[0020] If, in contrast and as shown in Figure 2, a pull-in current IA is applied to the drive coil 2, the armature 3 is deflected from its armature rest position AR to an armature operating position AB.

[0021] An initial movement force FV is applied by the initial movement spring device 6 in the opposite direction to that in which the armature 3 moves. This force is less than a driving force FM, which is likewise in the opposite direction to the direction in which the armature 3 moves and is applied by the driving spring device 7. The armature 3 is thus first of all deflected through an initial movement distance sV by the drive coil 2. For the armature 3 to pass through the initial movement distance sV, the drive coil 2 has to overcome only the initial movement force FV. Since the initial movement force FV is less than the driving force FM, the operating element 4 is not deflected while the armature 3 is passing through the initial movement distance sV, and remains in its element rest position ER.

[0022] At the end of the initial movement distance sV, the armature 3 is moved against a lower operating element stop 12, which is arranged on the operating element 4. The movement of the armature 3 against the lower operating element stop 12 means that the further deflection of the armature 3 to an armature operating position AB also results in the operating element 4 being deflected to an element operating position EB. The driving force FM must be overcome while passing through the driving movement distance sM, which is defined by the operating element 4 being driven.

[0023] The deflection of the operating element 4 results in contact pieces 13 on the contact link 5 being lowered, as illustrated in Figure 2, onto mating contacts 14, which are arranged fixed in the contactor housing 1. The operating element 4 is then also deflected somewhat further, so that, during the last section of the movement through the driving movement distance sM, referred to as the contact-making movement distance sD in the following text, it is necessary to overcome the driving force FM plus a contact-making force FD which is applied by the contact-making spring device 8.

[0024] The deflection of the operating element 4 thus results in operation of a contact which is formed firstly by the contact link 5 together with the contact pieces 13 and secondly by the mating contacts 14. As can be seen from Figures 1 and 2, the contact pieces 13 are lowered in vacuum containers 15 onto the mating contacts 14. The vacuum containers 15 in this case have at least one subsection 16 within which their lengths are variable. Since the contact pieces 13 and the mating contacts 14 are arranged in vacuum containers 15, the contact is a vacuum contact. The contactor is thus a vacuum contactor.

[0025] Figure 3 now shows, initially schematically, the force profile which the drive coil 2 has to overcome on the basis of the pull-in current 1. Only the initial movement force FV, which increases slightly along the initial movement distance sV, must be overcome while passing through the initial movement distance sV. During the driving movement distance sM,

on the other hand, the driving force FM must be overcome, and this likewise increases along the driving movement distance sM. In fact, the sum of the driving force FM and the contact-making force FD must be overcome during the contact-making movement distance sD.

[0026] The initial movement force FV is less than the driving force FM. As a rule, it is 10% to 50% of the driving force FM. The ratio of the initial movement force FV to the driving force FM is thus generally 1:10 to 1:2. The initial movement force FV is preferably between 20% and 25% of the driving force FM, and the ratio is thus preferably between 1:5 and 1:4.

[0027] It can also be seen from Figure 3 that the operating element 4 is deflected by the armature 3 only while the latter is passing through the driving movement distance sM. As a rule, the initial movement distance sV is 25% to 75% of the overall movement distance that the armature 3 passes through. In general, it is between 40% and 60% of the total movement distance. The ratio of the initial movement distance sV to the driving movement distance sM is thus generally between 1:3 and 3:1, and is normally between 2:3 and 3:2.

[0028] The driving force FM is governed essentially by the dimensions of the vacuum contact – or the vacuum contacts if there are a number of contacts to be switched. The initial movement force FV can, in contrast, in principle be chosen as required. Thus, in particular, it is possible to design the initial movement force FV to be similar to that in an air contactor with the same rating.

[0029] The driving movement distance sM is likewise governed essentially by the dimensions of the vacuum contactor. The initial movement distance sV can once again be chosen as required. In particular, the initial movement distance sV can be chosen such that the sum of the initial movement distance sV and of the driving movement distance sM corresponds to the movement distance through which the armature and the operating element of a comparable air contactor are moved. The drive coil 2 can thus be designed in the same way as for a comparable air contactor. This makes it possible, in particular, to achieve a vacuum contactor with a good tripping characteristic.

[0030] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

~~September 17, 2001~~
~~1999 P 03694 WO~~
~~PCT/DE00/03504~~

~~DE0003504~~

New PCT National Phase Application
Docket No. 32860-000306/US

~~Description~~

SUBSTITUTE SPECIFICATION

VACUUM CONTACTOR

This application is the national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/DE00/03504 which has an International filing date of October 5, 2000, which designated the United States of America, the entire contents of which are hereby incorporated by reference.

Field of the Invention

The present invention generally relates to a vacuum contactor. Preferably, it relates to one including ~~having~~ a contactor housing, a drive coil, an armature, an operating element and at least one vacuum contact~~,~~. Even more preferably,

~~with~~ the drive coil deflect~~sing~~ the armature from an armature rest position to an armature operating position when a pull-in current is applied~~,~~. T

~~with~~ the deflection of the armature then cause~~sing~~ the operating element to be deflected from an element rest position to an element operating position. Finally, ~~, and~~

~~with~~ the deflection of the operating element result~~sing~~ in closing of the at least one vacuum contact.

Background of the Invention

CH-A-169 467 discloses a vacuum contactor having a contactor housing, a drive coil, an armature, an operating element and at least one vacuum contact~~;~~

- with the drive coil deflecting the armature from an armature rest position to an armature operating position when a pull-in current is applied,
- with the deflection of the armature causing the operating element to be deflected from an element rest position to an element operating position,
- with the deflection of the operating element resulting in opening of the at least one vacuum contact,
- with, when the armature is deflected from the armature rest position to the armature operating position, the armature first of all passing through an initial movement distance, and then passing through a driving movement distance, and

- with the operating element being deflected by the armature only while the latter is passing through the driving movement distance.

GB 1 432 372 A discloses an air contactor having a contactor housing, a drive coil, an armature, an operating element and at least one contact~~,~~:

- with the drive coil deflecting the armature from an armature rest position to an armature operating position when a pull-in current is applied,
- with the deflection of the armature causing the operating element to be deflected from an element rest position to an element operating position,
- with the deflection of the operating element resulting in closing of the at least one contact,
- with, when the armature is deflected from the armature rest position to the armature operating position, the armature first of all passing through an initial movement distance, followed by a driving movement distance, and
- with the operating element being deflected by the armature only while the latter is passing through the driving movement distance.

In contactors, the armature~~,~~ and the operating element, together with the armature, ~~the operating element a~~are generally deflected against a spring force when the pull-in current is applied to the drive coil. The spring force thus acts in the direction of the armature rest position and of the element rest position. This spring force must be overcome by the pull-in torque which the drive coil exerts on the armature as a result of the pull-in current. The pull-in torque is dependent on the pull-in current, which is in turn dependent on the supply voltage that is supplied to the drive coil.

Both the pull-in torque and the spring force in the opposite direction vary along the distance through which the armature and the operating element are deflected. If the contactor is not well designed, it is thus possible for a situation to occur in which, if the
supply voltage is too low, although the armature and the operating element are deflected from their rest positions, the armature and the operating element are not deflected to their operating positions, however. In a case such as this, the armature and operating element either remain stuck in an intermediate position, or a contact which is operated by the operating element is only operated without a pressure. Depending on the duration of this state, this can lead to high wear, and generally also to damage, while in the extreme case, it can even lead to

destruction of the contactor.

In the case of air contactors, that is to say in contactors whose contacts are surrounded by air, it is possible to design these contactors such that the armature and operating element are either not deflected at all from their rest positions or else are moved completely to their operating positions. Such a contactor characteristic is referred to as a tripping characteristic.

Vacuum contactors require a greater spring force in the opposite direction than air contactors. This is because the vacuum pressure forces which would initiate autonomous operation of the contacts must be overcome. Until now, for vacuum contactors, it has been regarded as being impossible to achieve a tripping characteristic just on the basis of the mechanical/electrical design of the contactor. Vacuum contactors according to the prior art therefore either do not have a tripping characteristic or else drive electronics are connected upstream of the drive coil and apply the supply voltage to the drive coil only when the supply voltage is high enough to ensure that the armature and operating element will reliably be moved to the operating positions.

SUMMARY OF THE INVENTION

~~However, the inventors~~In an embodiment ~~of~~of the present invention, ~~have identified the fact that,~~ if the vacuum contactor is designed in a suitable manner, it is possible to achieve a tripping characteristic even without any upstream drive electronics. ~~The inventors of the present invention have therefore created a~~A vacuum contactor has been created, in one embodiment of the present application, in which the operating element always either remains in the element rest position or is deflected
completely to the element operating position when a current that is less than the pull-in current is applied to the drive coil.

This can occur~~is because~~ because, for example, the force which needs to be overcome along the initial movement distance can be chosen independently of the contact arrangement. ~~and,~~ ~~i~~In particular, it can be chosen independently of the fact that vacuum contacts are being operated. This allows a tripping characteristic to be achieved, if the vacuum contactor is designed in a suitable manner.

In vacuum contactors, arcs can be~~are~~ quenched even with small contact openings. Vacuum contactors therefore generally have shorter switching movements than air contactors. The dimensions that are known for air contactors can thus be used, provided the sum of the initial movement distance and the driving movement distance correspond to the contact movement distance of an air contactor. In practice, this corresponds to the ratio of the initial movement distance to the driving movement distance being between 1:3 and 3:1. In general, the ratio of the initial movement distance to the driving movement distance is between 2:3 and 3:2.

As already mentioned, the armature can be~~is~~ deflected against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance. A tripping characteristic can be achieved in a particularly highly reliable manner if the initial movement force is less than the driving force. In practice, this normally means that the ratio of the initial movement force to the driving force is between 1:10 and 1:2, in particular between 1:5 and 1:4.

The physical design of the vacuum contactor can be~~is~~ particularly simple if the initial movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, the initial movement spring device is supported firstly on the armature and secondly on the operating element, and the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

If the operating element has a stop, against which the armature is moved when it is deflected from the armature rest position, the initial movement distance can be~~is~~ defined exactly in a particularly simple manner.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages and details can be found in the following description of an exemplary embodiment. In this case, illustrated in outline form,

Figure 1 shows a vacuum contactor in the unoperated state,
Figure 2 shows the vacuum contactor from Figure 1 in the operated state, and
Figure 3 shows a force and movement profile plotted against the armature movement distance.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a vacuum contactor with a contactor housing 1. Only part of the contactor housing 1 is shown in Figure 1. A drive coil 2 is mounted rigidly in the contactor housing 1. An armature 3, an operating element 4 and a contact link 5 are also mounted, such that they can move, in the contactor housing 1.

The contactor has an initial movement spring device 6, a driving spring device 7 and a contact-making spring device 8. According to the exemplary embodiment, the spring devices 6-8 are in the form of compression spring devices. However, they could also be of ~~have a~~other different configurations, for example they could be in the form of rotary spring devices, etc.~~.~~

The initial movement spring device 6 is supported firstly on the armature 3 and secondly on the operating element 4. The driving spring device 7 is supported firstly on the operating element 4 and secondly on the contactor housing 1. The contact-making spring device 8 is supported firstly on the operating element 4 and secondly on the contact link 5.

When no current is applied to the drive coil 2, the initial movement spring device 6 presses the armature 3 against an upper operating element stop 9. The driving spring device 7 presses the operating element 4 against a housing stop 10. The contact-making spring device 8 presses the contact link 5 against a contact link stop 11. The armature 3 is thus in an armature rest position AR, the operating element 4 is in an element rest position ER, and the contact link 5 is in a link rest position. This position is shown in Figure 1.

If, in contrast and as shown in Figure 2, a pull-in current IA is applied to the drive coil 2, the armature 3 is deflected from its armature rest position AR to an armature operating position AB.

An initial movement force FV is applied by the initial movement spring device 6 in the opposite direction to that in which the armature 3 moves. This force is less than a driving force FM, which is likewise in the opposite direction to the direction in which the armature 3 moves and is applied by the driving spring device 7. The armature 3 is thus first of all

deflected through an initial movement distance sV by the drive coil 2. For the armature 3 to pass through the initial movement distance sV, the drive coil 2 has to overcome only the initial movement force FV. Since the initial movement force FV is less than the driving force FM, the operating element 4 is not deflected while the armature 3 is passing through the initial movement distance sV, and remains in its element rest position ER.

At the end of the initial movement distance sV, the armature 3 is moved against a lower operating element stop 12, which is arranged on the operating element 4. The movement of the armature 3 against the lower operating element stop 12 means that the further deflection of the armature 3 to an armature operating position AB also results in the operating element 4 being deflected to an element operating position EB. The driving force FM must be overcome while passing through the driving movement distance sM, which is defined by the operating element 4 being driven.
The deflection of the operating element 4 results in contact pieces 13 on the contact link 5 being lowered, as illustrated in Figure 2, onto mating contacts 14, which are arranged fixed in the contactor housing 1. The operating element 4 is then also deflected somewhat further, so that, during the last section of the movement through the driving movement distance sM, referred to as the contact-making movement distance sD in the following text, it is necessary to overcome the driving force FM plus a contact-making force FD which is applied by the contact-making spring device 8.

The deflection of the operating element 4 thus results in operation of a contact which is formed firstly by the contact link 5 together with the contact pieces 13 and secondly by the mating contacts 14. As can be seen from Figures 1 and 2, the contact pieces 13 are lowered in vacuum containers 15 onto the mating contacts 14. The vacuum containers 15 in this case have at least one subsection 16 within which their lengths are variable. Since the contact pieces 13 and the mating contacts 14 are arranged in vacuum containers 15, the contact is a vacuum contact. The contactor is thus a vacuum contactor.

Figure 3 now shows, initially schematically, the force profile which the drive coil 2 has to overcome on the basis of the pull-in current 1. Only the initial movement force FV, which increases slightly along the initial movement distance sV, must be overcome while passing through the initial movement distance sV. During the driving movement distance sM, on the other hand, the driving force FM must be overcome, and this likewise increases along the

driving movement distance sM. In fact, the sum of the driving force FM and the contact-making force FD must be overcome during the contact-making movement distance sD.

The initial movement force FV is less than the driving force FM. As a rule, it is 10% to 50% of the driving force FM. The ratio of the initial movement force FV to the driving force FM is thus generally 1:10 to 1:2. The initial movement force FV is preferably between 20% and 25% of the driving force FM, and the ratio is thus preferably between 1:5 and 1:4.

It can also be seen from Figure 3 that the operating element 4 is deflected by the armature 3 only while the latter is passing through the driving movement distance sM. As a rule, the initial movement distance sV is 25% to 75% of the overall movement distance that the armature 3 passes through. In general, it is between 40% and 60% of the total movement distance. The ratio of the initial movement distance sV to the driving movement distance sM is thus generally between 1:3 and 3:1, and is normally between 2:3 and 3:2.

The driving force FM is governed essentially by the dimensions of the vacuum contact – or the vacuum contacts if there are a number of contacts to be switched. The initial movement force FV can, in contrast, in principle be chosen as required. Thus, in particular, it is possible to design the initial movement force FV to be similar to that in an air contactor with the same rating.

The driving movement distance sM is likewise governed essentially by the dimensions of the vacuum contactor. The initial movement distance sV can once again be chosen as required. In particular, the initial movement distance sV can be chosen such that the sum of the initial movement distance sV and of the driving movement distance sM corresponds to the movement distance through which the armature and the operating element of a comparable air contactor are moved. The drive coil 2 can thus be designed in the same way as for a comparable air contactor. This makes it possible, in particular, to achieve a vacuum contactor with a good tripping characteristic.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

What is claimed is:~~Patent claims~~

1. (Amended) A vacuum contactor, comprising:
~~having~~ a contactor housing;~~(1),~~
-a drive coil~~(2),~~;
-an armature~~(3),~~;
-an operating element;~~(4)~~ and
-at least one vacuum contact, wherein
~~with~~ the drive coil is adapted to ~~(2)~~ deflect~~ing~~ the armature~~(3)~~ from an armature rest position ~~(AR)~~ to an armature operating position ~~(AB)~~ when a pull-in current ~~(IA)~~ is applied, wherein
~~with~~ the deflection of the armature is adapted to ~~(3)~~ cause~~ing~~ the operating element ~~(4)~~ to be deflected from an element rest position ~~(ER)~~ to an element operating position ~~(EB)~~, ~~and~~wherein
~~with~~ the deflection of the operating element ~~(4)~~ is adapted to result~~ing~~ in closing of the at least one vacuum contact,
~~with,~~ wherein when the armature ~~(3)~~ is deflected from the armature rest position ~~(AR)~~ to the armature operating position ~~(AB)~~, the armature ~~(3)~~ is adapted to first ~~of all~~ pass~~ing~~ through an initial movement distance ~~(sV),~~ and is then adapted to ~~then~~ pass~~ing~~ through a driving movement distance ~~(sM)~~,
with the operating element ~~(4)~~ being deflected by the armature ~~(3)~~ only while the armature~~latter~~ is passing through the driving movement distance ~~(sM)~~, and wherein
~~with~~ the operating element is adapted to ~~(4)~~ always either remain~~ing~~ in the element rest position ~~(ER)~~ or be~~being~~ deflected completely to the element operating position ~~(EB)~~ when a current that is less than the pull-in current ~~(IA)~~ is applied to the drive coil ~~(2)~~.

NEW CLAIMS

2. The vacuum contact as claimed in claim 1,
wherein the ratio of the initial movement distance to the driving movement distance is between 1:3 and 3:1.

3. The vacuum contactor as claimed in claim 1,
wherein the ratio of the initial movement distance to the driving movement distance is

between 2:3 and 3:2.

4. The vacuum contactor as claimed in claim 1, wherein the armature is deflected by the drive coil against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance, and wherein the initial movement force is less than the driving force.

5. The vacuum contactor as claimed in claim 4,
wherein the ratio of the initial movement force to the driving force is between 1:10 and 1:2.

6. The vacuum contact as claimed in claim 4,
wherein the ratio of the initial movement force to the driving force is between 1:5 and 1:4.

7. The vacuum contactor as claimed in claim 4,
wherein the initial movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, wherein the initial movement spring device is supported firstly on the armature and secondly on the operating element, and wherein the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

8. The vacuum contactor as claimed in claim 1,
wherein the operating element includes a stop, against which the armature is moved when it is deflected from the armature rest position.

9. The vacuum contactor as claimed in claim 2, wherein the armature is deflected by the drive coil against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance, and wherein the initial movement force is less than the driving force.

10. The vacuum contactor as claimed in claim 9,
wherein the ratio of the initial movement force to the driving force is between 1:10 and 1:2.

11. The vacuum contact as claimed in claim 9,
wherein the ratio of the initial movement force to the driving force is between 1:5 and 1:4.

12. The vacuum contactor as claimed in claim 3, wherein the armature is deflected by the drive coil against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance, and wherein the initial movement force is less than the driving force.

13. The vacuum contactor as claimed in claim 12,
wherein the ratio of the initial movement force to the driving force is between 1:10 and 1:2.

14. The vacuum contact as claimed in claim 12,
wherein the ratio of the initial movement force to the driving force is between 1:5 and 1:4.

15. The vacuum contactor as claimed in claim 5,
wherein the initial movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, wherein the initial movement spring device is supported firstly on the armature and secondly on the operating element, and wherein the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

16. The vacuum contactor as claimed in claim 6,
wherein the initial movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, wherein the initial movement spring device is supported firstly on the armature and secondly on the operating element, and wherein the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

17. The vacuum contactor as claimed in claim 2,
wherein the operating element includes a stop, against which the armature is moved when it is deflected from the armature rest position.

~~18. The vacuum contactor as claimed in claim 3,~~
~~wherein the operating element includes a stop, against which the armature is moved when it is deflected from the armature rest position.~~

19. The vacuum contactor as claimed in claim 4,
wherein the operating element includes a stop, against which the armature is moved when it

is deflected from the armature rest position.

19. A method of operating a vacuum contactor including a drive coil, an armature, an operating element, and at least one vacuum contact, comprising:

applying a pull-in current to the drive coil to deflect the armature from an armature rest position to an armature operating position;

causing, from the deflection of the armature, the operating element to be deflected from an element rest position to an element operating position;

causing, from the deflection of the operating element, closing of the at least one vacuum contact; and

causing, when the armature is deflected from the armature rest position to the armature operating position, the armature to first pass through an initial movement distance and then pass through a driving movement distance, with the operating element being deflected by the armature only while the armature is passing through the driving movement distance, and wherein the operating element is adapted to always either remain in the element rest position or be deflected completely to the element operating position when a current that is less than the pull-in current is applied to the drive coil.

20. An apparatus, comprising:

a vacuum contactor including a drive coil, an armature, an operating element, and at least one vacuum contact; and

means for applying a pull-in current to the drive coil to deflect the armature from an armature rest position to an armature operating position, wherein, from the deflection of the armature, the operating element is adapted to be deflected from an element rest position to an element operating position, wherein, from the deflection of the operating element, the at least one vacuum contact is adapted to be closed, wherein, when the armature is deflected from the armature rest position to the armature operating position, the armature is adapted to first pass through an initial movement distance and then pass through a driving movement distance, with the operating element being deflected by the armature only while the armature is passing through the driving movement distance, and wherein the operating element is adapted to always either remain in the element rest position or be deflected completely to the element operating position when a current that is less than the pull-in current is applied to the drive coil.

Abstract

~~Vacuum contactor~~

In a vacuum contactor, the armature ~~(3)~~ is initially deflected from an armature rest position ~~(AR)~~ through an initial movement distance ~~(sV)~~, and then through a driving movement distance ~~(sM)~~ to an armature operating position ~~(AB)~~ when a pull-in current ~~(IA)~~ is applied to a drive coil ~~(2)~~. An operating element ~~(4)~~ is deflected from an element rest position ~~(ER)~~ to an element operating position ~~(EB)~~ by the armature ~~(3)~~ only while the latter is passing through the driving movement distance ~~(sM)~~. This makes it possible to achieve a good tripping characteristic of the vacuum contractor.

~~Figure 1~~

Description

Vacuum contactor

The present invention relates to a vacuum contactor having a contactor housing, a drive coil, an armature, an operating element and at least one vacuum contact,

- with the drive coil deflecting the armature from an armature rest position to an armature operating position when a pull-in current is applied,
- with the deflection of the armature causing the operating element to be deflected from an element rest position to an element operating position, and
- with the deflection of the operating element resulting in closing of the at least one vacuum contact.

CH-A-169 467 discloses a vacuum contactor having a contactor housing, a drive coil, an armature, an operating element and at least one vacuum contact,

- with the drive coil deflecting the armature from an armature rest position to an armature operating position when a pull-in current is applied,
- with the deflection of the armature causing the operating element to be deflected from an element rest position to an element operating position,
- with the deflection of the operating element resulting in opening of the at least one vacuum contact,
- with, when the armature is deflected from the armature rest position to the armature operating position, the armature first of all passing through an initial movement distance, and then passing through a driving movement distance, and

- with the operating element being deflected by the armature only while the latter is passing through the driving movement distance.

GB 1 432 372 A discloses an air contactor having a contactor housing, a drive coil, an armature, an operating element and at least one contact,

- with the drive coil deflecting the armature from an armature rest position to an armature operating position when a pull-in current is applied,
- with the deflection of the armature causing the operating element to be deflected from an element rest position to an element operating position,
- with the deflection of the operating element resulting in closing of the at least one contact,
- with, when the armature is deflected from the armature rest position to the armature operating position, the armature first of all passing through an initial movement distance, followed by a driving movement distance, and
- with the operating element being deflected by the armature only while the latter is passing through the driving movement distance.

In contactors, the armature, and, together with the armature, the operating element are generally deflected against a spring force when the pull-in current is applied to the drive coil. The spring force thus acts in the direction of the armature rest position and of the element rest position. This spring force must be overcome by the pull-in torque which the drive coil exerts on the armature as a result of the pull-in current. The pull-in torque is dependent on the pull-in current, which is in turn dependent on the supply voltage that is supplied to the drive coil.

Both the pull-in torque and the spring force in the opposite direction vary along the distance through which the armature and the operating element are deflected. If the contactor is not well designed, it is

thus possible for a situation to occur in which, if the supply voltage is too low, although the armature and the operating element are deflected from their rest positions, the armature and the operating element are not deflected to their operating positions, however. In a case such as this, the armature and operating element either remain stuck in an intermediate position, or a contact which is operated by the operating element is only operated without a pressure. Depending on the duration of this state, this can lead to high wear, and generally also to damage, while in the extreme case, it can even lead to destruction of the contactor.

In the case of air contactors, that is to say in contactors whose contacts are surrounded by air, it is possible to design these contactors such that the armature and operating element are either not deflected at all from their rest positions or else are moved completely to their operating positions. Such a contactor characteristic is referred to as a tripping characteristic.

Vacuum contactors require a greater spring force in the opposite direction than air contactors. This is because the vacuum pressure forces which would initiate autonomous operation of the contacts must be overcome. Until now, for vacuum contactors, it has been regarded as being impossible to achieve a tripping characteristic just on the basis of the mechanical/electrical design of the contactor. Vacuum contactors according to the prior art therefore either do not have a tripping characteristic or else drive electronics are connected upstream of the drive coil and apply the supply voltage to the drive coil only when the supply voltage is high enough to ensure that the armature and operating element will reliably be moved to the operating positions.

However, the inventors of the present invention have identified the fact that, if the vacuum contactor is designed in a suitable manner, it is possible to achieve a tripping characteristic even without any upstream drive electronics. The inventors of the present invention have therefore created a vacuum contactor in which the operating element always either remains in the element rest position or is deflected

completely to the element operating position when a current that is less than the pull-in current is applied to the drive coil.

This is because the force which needs to be overcome along the initial movement distance can be chosen independently of the contact arrangement and, in particular, independently of the fact that vacuum contacts are being operated. This allows a tripping characteristic to be achieved, if the vacuum contactor is designed in a suitable manner.

In vacuum contactors, arcs are quenched even with small contact openings. Vacuum contactors therefore generally have shorter switching movements than air contactors. The dimensions that are known for air contactors can thus be used, provided the sum of the initial movement distance and the driving movement distance correspond to the contact movement distance of an air contactor. In practice, this corresponds to the ratio of the initial movement distance to the driving movement distance being between 1:3 and 3:1. In general, the ratio of the initial movement distance to the driving movement distance is between 2:3 and 3:2.

As already mentioned, the armature is deflected against an initial movement force while it is passing through the initial movement distance, and against a driving force while it is passing through the driving movement distance. A tripping characteristic can be achieved in a particularly highly reliable manner if the initial movement force is less than the driving force. In practice, this normally means that the ratio of the initial movement force to the driving force is between

1:10 and 1:2, in particular between 1:5 and 1:4.

The physical design of the vacuum contactor is particularly simple if the initial movement force is applied by an initial movement spring device, and the driving force is applied by a driving spring device, the initial movement spring device is supported firstly on the armature and secondly on the operating element, and the driving spring device is supported firstly on the operating element and secondly on the contactor housing.

If the operating element has a stop, against which the armature is moved when it is deflected from the armature rest position, the initial movement distance is defined exactly in a particularly simple manner.

Further advantages and details can be found in the following description of an exemplary embodiment. In this case, illustrated in outline form,

Figure 1 shows a vacuum contactor in the unoperated state,

Figure 2 shows the vacuum contactor from Figure 1 in the operated state, and

Figure 3 shows a force and movement profile plotted against the armature movement distance.

Figure 1 shows a vacuum contactor with a contactor housing 1. Only part of the contactor housing 1 is shown in Figure 1. A drive coil 2 is mounted rigidly in the contactor housing 1. An armature 3, an operating element 4 and a contact link 5 are also mounted, such that they can move, in the contactor housing 1.

The contactor has an initial movement spring device 6, a driving spring device 7 and a contact-making spring device 8. According to the exemplary embodiment, the spring devices 6-8 are in the form of compression spring devices. However, they could also have a different configuration, for example be in the form of rotary spring devices.

The initial movement spring device 6 is supported firstly on the armature 3 and secondly on the operating element 4. The driving spring device 7 is supported firstly on the operating element 4 and secondly on the contactor housing 1. The contact-making spring device 8 is supported firstly on the operating element 4 and secondly on the contact link 5.

When no current is applied to the drive coil 2, the initial movement spring device 6 presses the armature 3 against an upper operating element stop 9. The driving

spring device 7 presses the operating element 4 against a housing stop 10. The contact-making spring device 8 presses the contact link 5 against a contact link stop 11. The armature 3 is thus in an armature rest position AR, the operating element 4 is in an element rest position ER, and

the contact link 5 is in a link rest position. This position is shown in Figure 1.

If, in contrast and as shown in Figure 2, a pull-in current IA is applied to the drive coil 2, the armature 3 is deflected from its armature rest position AR to an armature operating position AB.

An initial movement force FV is applied by the initial movement spring device 6 in the opposite direction to that in which the armature 3 moves. This force is less than a driving force FM, which is likewise in the opposite direction to the direction in which the armature 3 moves and is applied by the driving spring device 7. The armature 3 is thus first of all deflected through an initial movement distance sV by the drive coil 2. For the armature 3 to pass through the initial movement distance sV, the drive coil 2 has to overcome only the initial movement force FV. Since the initial movement force FV is less than the driving force FM, the operating element 4 is not deflected while the armature 3 is passing through the initial movement distance sV, and remains in its element rest position ER.

At the end of the initial movement distance sV, the armature 3 is moved against a lower operating element stop 12, which is arranged on the operating element 4. The movement of the armature 3 against the lower operating element stop 12 means that the further deflection of the armature 3 to an armature operating position AB also results in the operating element 4 being deflected to an element operating position EB. The driving force FM must be overcome while passing through the driving movement distance sM, which is defined by the operating element 4 being driven.

The deflection of the operating element 4 results in contact pieces 13 on the contact link 5 being lowered, as illustrated in Figure 2, onto mating contacts 14, which are arranged fixed in the contactor housing 1. The operating element 4 is then also deflected somewhat further, so that, during the last section of the movement through

the driving movement distance sM, referred to as the contact-making movement distance sD in the following text, it is necessary to overcome the driving force FM plus a contact-making force FD which is applied by the contact-making spring device 8.

The deflection of the operating element 4 thus results in operation of a contact which is formed firstly by the contact link 5 together with the contact pieces 13 and secondly by the mating contacts 14. As can be seen from Figures 1 and 2, the contact pieces 13 are lowered in vacuum containers 15 onto the mating contacts 14. The vacuum containers 15 in this case have at least one subsection 16 within which their lengths are variable. Since the contact pieces 13 and the mating contacts 14 are arranged in vacuum containers 15, the contact is a vacuum contact. The contactor is thus a vacuum contactor.

Figure 3 now shows, initially schematically, the force profile which the drive coil 2 has to overcome on the basis of the pull-in current 1. Only the initial movement force FV, which increases slightly along the initial movement distance sV, must be overcome while passing through the initial movement distance sV. During the driving movement distance sM, on the other hand, the driving force FM must be overcome, and this likewise increases along the driving movement distance sM. In fact, the sum of the driving force FM and the contact-making force FD must be overcome during the contact-making movement distance sD.

The initial movement force FV is less than the driving force FM. As a rule, it is 10% to 50% of the driving force FM. The ratio of the initial movement force FV to the driving force FM is thus generally 1:10 to 1:2. The initial movement force FV is preferably between 20% and

25% of the driving force FM, and the ratio is thus preferably between 1:5 and 1:4.

It can also be seen from Figure 3 that the operating element 4 is deflected by the armature 3 only while the latter is passing through the driving movement distance sM. As a rule, the initial movement distance sV is

25% to 75% of the overall movement distance that the armature 3 passes through. In general, it is between 40% and 60% of the total movement distance. The ratio of the initial movement distance sV to the driving movement distance sM is thus generally between 1:3 and 3:1, and is normally between 2:3 and 3:2.

The driving force FM is governed essentially by the dimensions of the vacuum contact - or the vacuum contacts if there are a number of contacts to be switched. The initial movement force FV can, in contrast, in principle be chosen as required. Thus, in particular, it is possible to design the initial movement force FV to be similar to that in an air contactor with the same rating.

The driving movement distance sM is likewise governed essentially by the dimensions of the vacuum contactor. The initial movement distance sV can once again be chosen as required. In particular, the initial movement distance sV can be chosen such that the sum of the initial movement distance sV and of the driving movement distance sM corresponds to the movement distance through which the armature and the operating element of a comparable air contactor are moved. The drive coil 2 can thus be designed in the same way as for a comparable air contactor. This makes it possible, in particular, to achieve a vacuum contactor with a good tripping characteristic.

Patent claims

1. A vacuum contactor having a contactor housing (1), a drive coil (2), an armature (3), an operating element (4) and at least one vacuum contact,

- with the drive coil (2) deflecting the armature (3) from an armature rest position (AR) to an armature operating position (AB) when a pull-in current (IA) is applied,
- with the deflection of the armature (3) causing the operating element (4) to be deflected from an element rest position (ER) to an element operating position (EB), and
- with the deflection of the operating element (4) resulting in operation of the at least one vacuum contact,

characterized
in that, when the armature (3) is deflected from the armature rest position (AR) to the armature operating position (AB), the armature (3) first of all passes through an initial movement distance (sV), and then passes through a driving movement distance (sM), and in that the operating element (4) is deflected by the armature (3) only while the latter is passing through the driving movement distance (sM).

2. The vacuum contact as claimed in claim 1, characterized
in that the ratio of the initial movement distance (sV) to the driving movement distance (sM) is between 1:3 and 3:1.

3. The vacuum contactor as claimed in claim 2, characterized
in that the ratio of the initial movement distance (sV) to the driving movement distance (sM) is between 2:3 and 3:2.

4. The vacuum contactor as claimed in claim 1, 2 or 3, characterized
in that the armature (3) is deflected by the drive coil (2) against an initial movement force (FV) while it is passing through the initial movement distance (sV), and against a driving force (FM)

while it is passing through the driving movement distance (sM), and in that the initial movement force (FV) is less than the driving force (FM).

5. The vacuum contactor as claimed in claim 4, characterized
in that the ratio of the initial movement force (FV) to the driving force (FM) is between 1:10 and 1:2.

6. The vacuum contact as claimed in claim 5, characterized
in that the ratio of the initial movement force (FV) to the driving force (FM) is between 1:5 and 1:4.

7. The vacuum contactor as claimed in claim 4, 5 or 6,
characterized in that the initial movement force (FV) is applied by an initial movement spring device (6), and the driving force (FV) is applied by a driving spring device (7), in that the initial movement spring device (6) is supported firstly on the armature (3) and secondly on the operating element (4), and in that the driving spring device (7) is supported firstly on the operating element (4) and secondly on the contactor housing (1).

8. The vacuum contactor as claimed in one of the above claims,
characterized
in that the operating element (4) has a stop (12), against which the armature (3) is moved when it is deflected from the armature rest position (AR).

GR 99 P 3694

Abstract

Vacuum contactor

In a vacuum contactor, the armature (3) is initially deflected from an armature rest position (AR) through an initial movement distance (sV), and then through a driving movement distance (sM) to an armature operating position (AB) when a pull-in current (IA) is applied to a drive coil (2). An operating element (4) is deflected from an element rest position (ER) to an element operating position (EB) by the armature (3) only while the latter is passing through the driving movement distance (sM). This makes it possible to achieve a good tripping characteristic of the vacuum contractor.

Figure 1

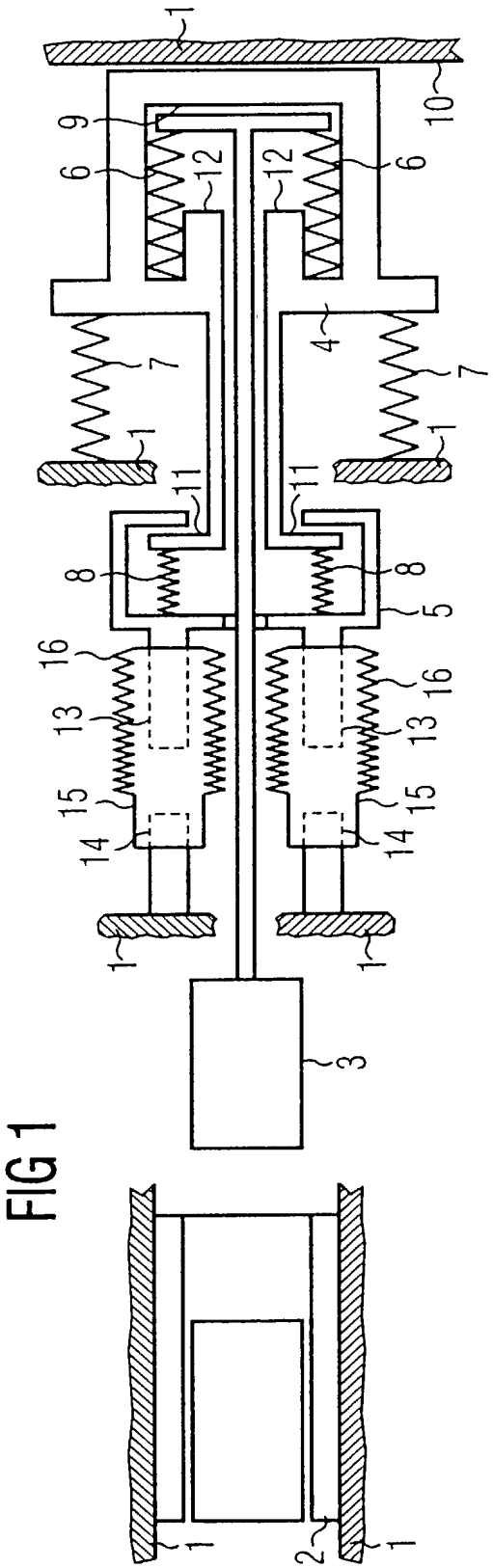
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FIG 1

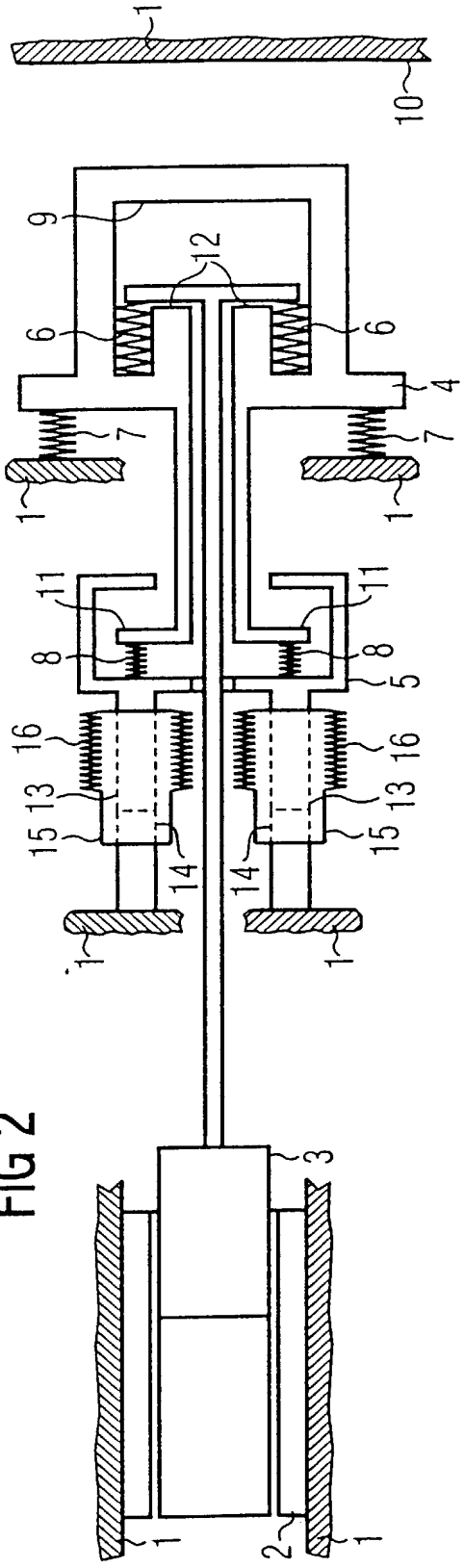
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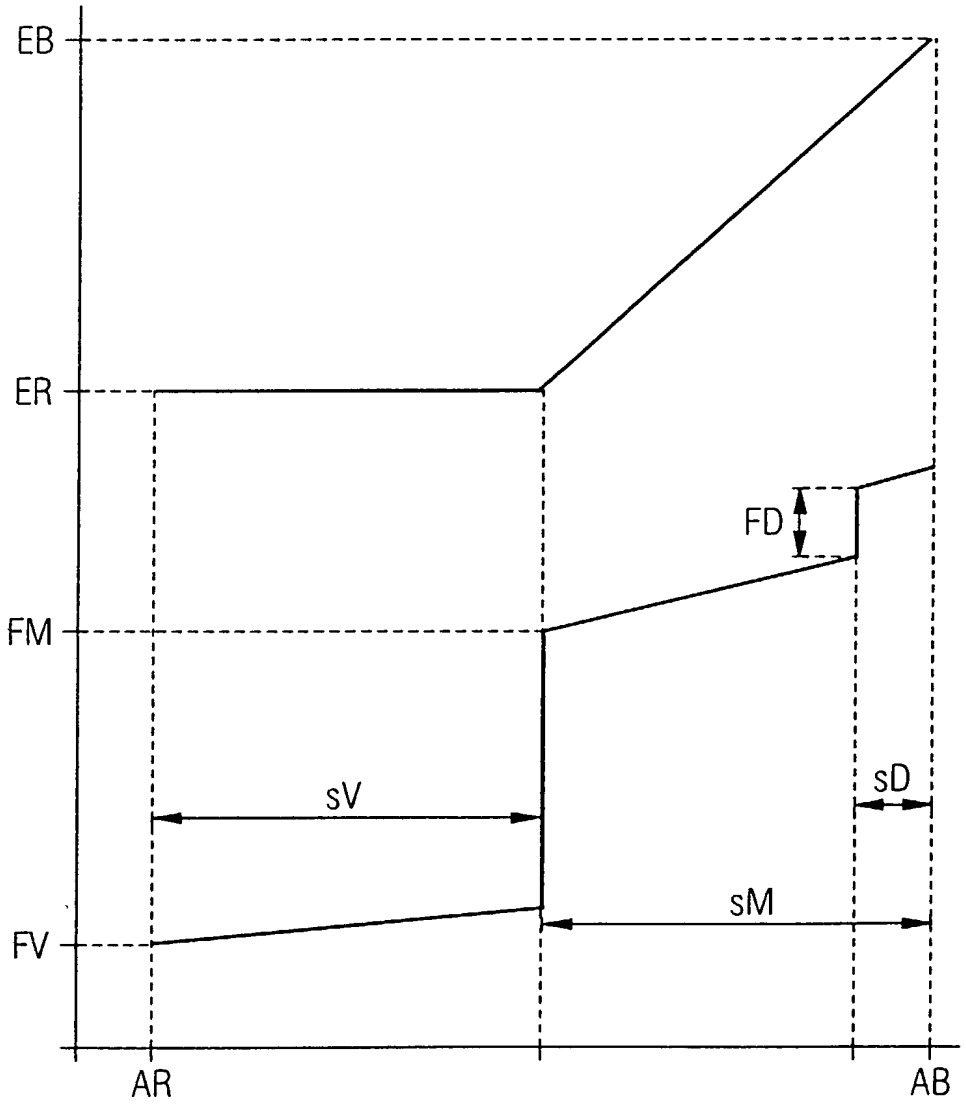
FIG 2

FIG 3



Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

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I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

VAKUUMSCHÜTZ

VACUUM CONTACTOR

deren Beschreibung

the specification of which

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 05.10.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/03504
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I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

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I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

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I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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Prior foreign appplications
Priorität beansprucht

			Priority Claimed	
19947836.8	DE	05.10.1999	☒	☐
(Number)	(Country)	(Day Month Year Filed)	Yes	No
(Nummer)	(Land)	(Tag Monat Jahr eingereicht)	Ja	Nein
			☐	☐
(Number)	(Country)	(Day Month Year Filed)	Yes	No
(Nummer)	(Land)	(Tag Monat Jahr eingereicht)	Ja	Nein
			☐	☐
(Number)	(Country)	(Day Month Year Filed)	Yes	No
(Nummer)	(Land)	(Tag Monat Jahr eingereicht)	Ja	Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

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PCT/DE00/03504	05.10.2000		pending
(Application Serial No)	(Filing Date D, M, Y)	(Status)	(Status)
(Anmeldeseriennummer)	(Anmeldedatum T, M, J)	(patentiert, anhangig, aufgegeben)	(patented, pending, abandoned)
(Application Serial No)	(Filing Date D,M,Y)	(Status)	(Status)
(Anmeldeseriennummer)	(Anmeldedatum T, M, J)	(patentiert, anhangig, aufgeben)	(patented, pending, abandoned)

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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Staatsangehörigkeit	Citizenship
DEUTSCH	GERMAN
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(Supply similar information and signature for third and subsequent joint inventors).

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Unterschrift des Erfinders / Datum 22.3.02	Inventor's signature / Date
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Staatsangehörigkeit DEUTSCH	Citizenship GERMAN
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Unterschrift des Erfinders / Datum	Inventor's signature / Date
Wohnsitz ,	Residence ,
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address

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(Supply similar information and signature for third and subsequent joint inventors).